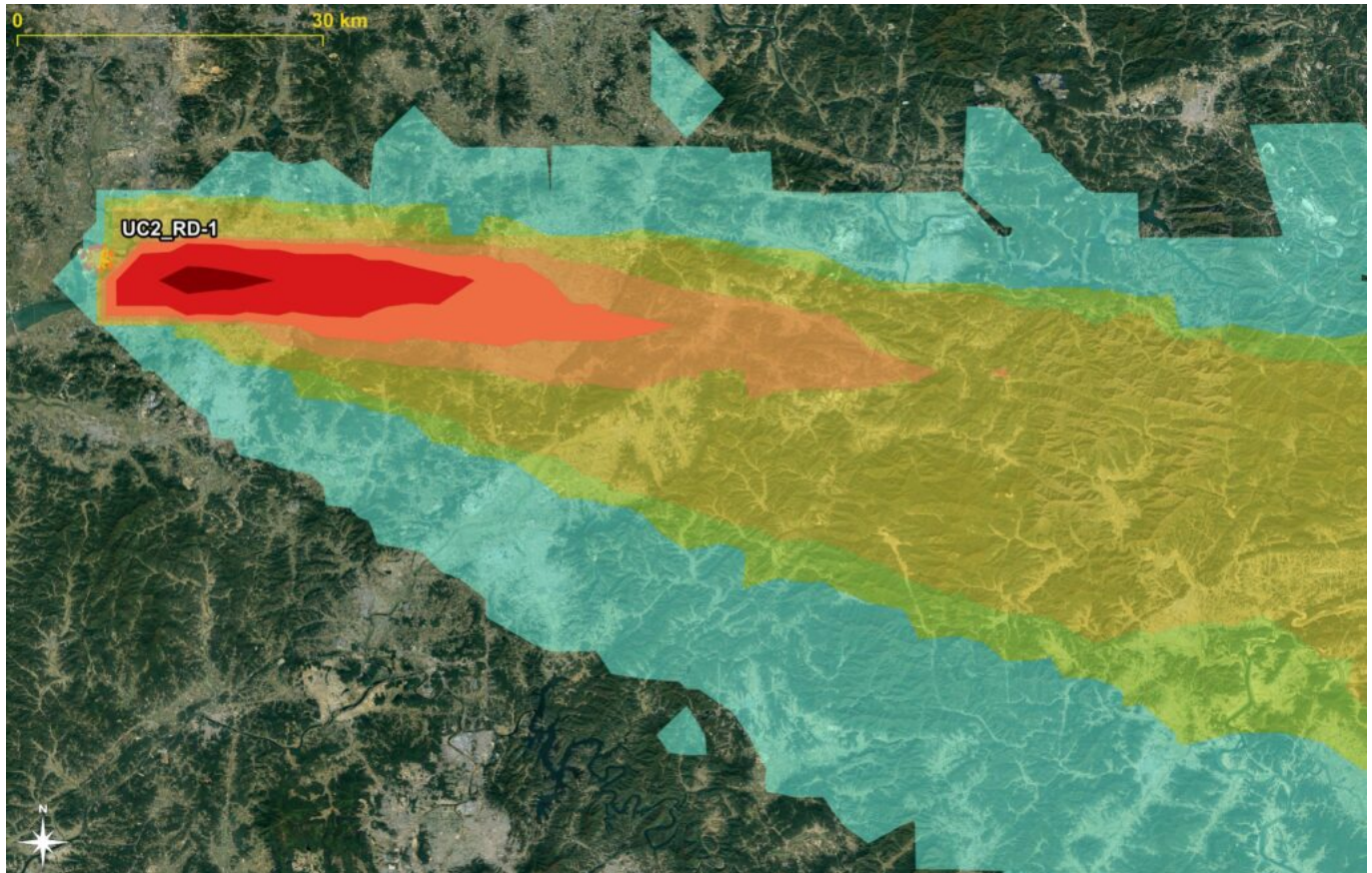




HUMANITARIAN IMPACTS OF NUCLEAR WEAPONS USE IN NORTHEAST ASIA: IMPLICATIONS FOR REDUCING NUCLEAR RISK



Recommended Citation

DAVID VON HIPPEL, EVA LISOWSKI, PETER HAYES, SHATABHISHA SHETTY, TATSUJIRO SUZUKI, FUMIHIKO YOSHIDA, MICHIRU NISHIDA, STEVE FREEDKIN, "HUMANITARIAN IMPACTS OF NUCLEAR WEAPONS USE IN NORTHEAST ASIA: IMPLICATIONS FOR REDUCING NUCLEAR RISK", NAPSNet Special Reports, March 31, 2023, <https://nautilus.org/napsnet/napsnet-special-reports/humanitarian-impacts-of-nuclear-weapons-use-in-northeast-asia-implications-for-reducing-nuclear-risk/>

DAVID VON HIPPEL, EVA LISOWSKI, PETER HAYES, SHATABHISHA

SHETTY, TATSUJIRO SUZUKI, FUMIHIKO YOSHIDA, MICHIRU NISHIDA, STEVE FREEDKIN

MARCH 31 2023

I. INTRODUCTION

This report summarizes the second year of work on estimating the humanitarian impacts of nuclear war in Northeast Asia. Based on five of the thirty plausible nuclear use cases developed in year 1 (see report [here](#)), the year 2 report produced quantitative estimates of the likely direct deaths and delayed cancer deaths resulting from nuclear weapons use. Even in the most limited of nuclear conflicts, deaths were in the tens or hundreds of thousands, with the more extensive conflicts resulting in millions of deaths and hundreds of thousands of cancer deaths. The report suggests a number measures to reduce the risk of choosing or stumbling onto one of these pathways by developing and applying regional and global policy measures such as increasing transparency of nuclear stockpiles, deployments, and operational and declaratory doctrine—especially relating to integration of nuclear firestorms into nuclear targeting—such as increasing communications with nuclear hotlines as well as reducing the role of nuclear weapons in international affairs by introducing a nuclear no-first threat norm; resolving regional conflicts; and, ultimately, establishing a regional security framework including denuclearization of the Korean Peninsula and a nuclear weapon free zone in the region towards elimination of nuclear weapons altogether.

The full year 2 report (English) is found [here](#) (PDF, 27.6MB)

The Executive Summary is provided below in English and [here](#), Chinese [here](#) Japanese [here](#) Korean [here](#) Russian [here](#) (live PDF file links)

This report is a part of a joint project on [Reducing the Risk of Nuclear Weapon Use in Northeast Asia \(NU-NEA\)](#) and has been cross-posted by the Asia Pacific Leadership Network [here](#), and the Research Center for Nuclear Weapons Abolition (RECNA) and the Panel on Peace and Security of North East Asia (PSNA) [here](#)

Acknowledgements: Ted Postol and Lynn Eden provided advice and documentation related to this report with regard to nuclear firestorms. Noboru Takamura, Atomic Bomb Disease Institute, Nagasaki University provided scientific advice on radiation health impacts of the nuclear explosions at Hiroshima and Nagasaki. Copyediting by Maureen Jerrett.

The views expressed in this report do not necessarily reflect the official policy or position of the Nautilus Institute. Readers should note that Nautilus seeks a diversity of views and opinions on significant topics in order to identify common ground.

This report is published under a 4.0 International Creative Commons License the terms of which are found [here](#).

Acknowledgement: This project is funded by Nagasaki University, APLN, the Nautilus Institute, the John D. and Catherine T. MacArthur Foundation, the New Land Foundation, and the Samuel Rubin Foundation

Banner image: Fallout radiation exposure map from a detonation at Camp Humphries, ROK. Source: HYSPLIT/QGIS simulation by Eva Lisowski and David von Hippel, Nautilus Institute.

II. NAPSNET SPECIAL REPORT BY DAVID VON HIPPEL, EVA LISOWSKI, PETER HAYES, SHATABHISHA SHETTY, TATSUJIRO SUZUKI, FUMIHIKO YOSHIDA, MICHIRU NISHIDA, STEVE FREEDKIN

HUMANITARIAN IMPACTS OF NUCLEAR WEAPONS USE IN NORTHEAST ASIA: IMPLICATIONS FOR REDUCING NUCLEAR RISK

MARCH 31 2023

Executive Summary

The risk of nuclear war—that is, the risk of attacks carried out by detonating nuclear weapons, hereafter “nuclear weapons use”—as of early 2023 is judged by many observers to be at its highest since the end of the Cold War. This risk is increasing due to nuclear threat-making during the Ukraine conflict, the India-Pakistan conflict, the Korean conflict, and the Middle Eastern conflict. Northeast Asia represents one of four potential flash points where nuclear weapons might be used for the first time since the last time they were used, on Nagasaki on August 9, 1945—hereafter called “first use” in this report.[\[1\]](#)

Northeast Asia includes two nuclear weapons states (China and Russia), a third nuclear weapons state with a key presence as a guarantor of security (the United States), a fourth and more recent self-declared, if not universally accepted, nuclear-armed state (the Democratic People’s Republic of Korea, or DPRK), and two non-nuclear weapons nations under the US “nuclear umbrella” with the technology to produce nuclear weapons and at least some voices arguing for access to or ownership of nuclear weapons (the Republic of Korea, or ROK, and Japan). Add to this group of actors the long-simmering and occasionally boiling issue of nuclear weapons on the Korean Peninsula, tensions over Taiwan, and other regional disputes, and a number of potential nuclear weapons “use cases” become plausible.

The second year of the Project on Reducing the Risk of Nuclear Weapons Use in Northeast Asia (NU-NEA), set out to better understand the risks of nuclear weapons use in the region. To this end, we produced quantitative estimates of the likely direct deaths and delayed cancer deaths resulting from nuclear weapons use. Five different nuclear “use cases” were simulated and analyzed. The hypothesized use cases were designed to be plausible, span a range of outcomes from a single detonation to limited global nuclear war, and include a range of nuclear actors and targets initiated in Northeast Asia, involving the Korean Peninsula, and in some cases spreading to other regions or continents. The estimated deaths and radiation-induced cancers resulting from the following six impacts were evaluated:

- Thermal fluence (heat) from nuclear blasts.
- Firestorms: multiple fires lit by thermal fluence that coalesce into large-area conflagrations encircled by hurricane-force winds as the heat rising from the fires pulls cooler air in behind it. Physical damage caused by blast overpressure provides fuel for firestorms, which could burn for weeks.
- Blast overpressure, causing building damage and collapse.
- Prompt radiation from the nuclear detonation itself.
- Fallout radiation, as radioactive material from the blast and contaminated debris are spread by wind and rain.
- Radiation-induced cancer deaths suffered by those exposed to prompt and fallout radiation but not

killed by the nuclear blast immediately or in the short term (within several months to a year).

Out of the 30 plausible use cases developed in Year 1 of the NU-NEA project, five use cases were simulated and evaluated quantitatively:

1. “We’re Still Here” Variant 1, involving nuclear weapons use by the DPRK followed by the United States, with 3 total detonations of 10 kT (kiloton) and 8 kT weapons.
2. “US Leadership Hubris,” involving first nuclear weapons use by the United States, followed by use by the DPRK, and China, with 18 total detonations ranging in yield from 8 to 300 kT.
3. “Use by Terrorists” Variant 1, with one 10 kT weapon detonated by a terrorist group.
4. “Conflict from Ukraine Spreads East,” involving first nuclear weapons use by Russia and followed by the United States, totaling eight detonations of 8, 150, and 200 kT weapons.
5. “Not Going Well in Taiwan,” involving first nuclear weapons use by China followed by responses from the United States, with a total of 24 detonations ranging in yield from 8 to 300 kT.

The table below summarizes the estimated prompt and short-term deaths and radiation-induced cancer deaths resulting from the impacts above for each of the five use cases evaluated. Even in the most limited of nuclear conflicts, deaths were in the tens or hundreds of thousands, with the more extensive conflicts resulting in millions of deaths and hundreds of thousands of cancer deaths. It should be noted that even the most extensive conflicts evaluated here were halted short of an all-out exchange of intercontinental nuclear missile attacks, but certainly could have ended that way. In the table below, “prompt” deaths are those caused by physical damage or fires in the immediate aftermath of detonations, including victims not killed immediately but dying within days or weeks, and “short-term” deaths include victims who succumbed to their injuries within the year following the nuclear attack.

Estimated Likely Direct and Cancer Deaths in Each of Five Modeled Use Cases[\[2\]](#)

Estimated Likely Deaths	Prompt (days to weeks)	Short-Term (weeks to months)	Additional Impact: Firestorms	Total Fatalities within 0.5 psi Zone (Total Population, % Lethality)	High Radiation Dose (Fallout) (short-term deaths)	Radiation-induced Cancer (long-term deaths)
Use Case 1 Airburst: 1, Surface-burst: 2	5,500	5,600	Firestorm Unlikely	11,000 (41,000, 27%)	Low Fallout	16,000 - 36,000
Use Case 2 Airburst: 11, Surface-burst: 7	1,100,000	810,000	170,000	2,100,000 (6,200,000, 33%)	11,000 - 1,200,000	480,000 - 920,000
Use Case 3 Surface-burst: 1	82,000	140,000	Small Centralized Firestorm	220,000 (890,000, 25%)	0 - 1,600,000	410,000 - 560,000
Use Case 4 Airburst: 8	170,000	100,000	15,000	290,000 (800,000, 36%)	Low Fallout	14,000 - 85,000
Use Case 5 Airburst: 16, Surface-burst: 8	1,500,000	930,000	190,000	2,600,000 (7,600,000, 35%)	400 - 19,000	96,000 - 830,000

These results show that use cases that include many high-yield (50-300 kT) airbursts result in a higher relative impact, roughly 35% lethality, than use cases with a limited number of detonations or with mostly surface-bursts, which average roughly 25% lethality. As a conflict escalates, especially when progressively larger nuclear detonations target more populated areas, the humanitarian impacts of a nuclear conflict not only increase, but often grow by orders of magnitude. One contributing impact is the occurrence of deadly firestorms resulting from high- yield weapons detonated as airbursts that cause far-ranging thermal fluence, demonstrating that firestorms can be a significant contributor to the lethality of nuclear weapons. Furthermore, even use cases with a limited number of surface-bursts or using weapons of relatively low yield can cause a disproportionately high number of fatalities when acute health effects from high radiation doses and

long-term cancer deaths are considered.

In Use Case 3, for example, a single surface-burst in an urban area results in estimated cancer fatalities on the same order of magnitude as the limited global nuclear war cases shown in Use Cases 2 and 5. The death toll in the short-term from exposure to high fallout radiation could also be the same or higher in Use Case 3, even though only one nuclear weapon has been detonated in an urban area. This result emphasizes how unpredictable the long-term and health impacts of nuclear use cases can be because it is nearly impossible to foresee whether a conflict will end after one detonation, 18 detonations, 24 detonations, or more, and whether urban areas will be targeted. Even when the conflict does not escalate to global nuclear war, it is possible that impacts consistent with those expected in a global-scale nuclear war can be felt after only one nuclear detonation.

In addition to devastating losses of human life, a range of economic and societal impacts, such as billions of dollars in infrastructure damage and health care costs, and a further set of global, regional, and local ecological impacts such as climate effects or effects on oceans, would also result from these use cases. The evaluation of these and other impacts will be addressed in the third project year.

The use cases evaluated in the NU-NEA project are intended to be plausible, but they capture only a small fraction of the possible pathways to nuclear war and its consequences identified in this project, which in turn do not even begin to encapsulate the universe of possible ways that a nuclear conflict could start and play out. Several conclusions, however, can be drawn from the limited number of use cases evaluated in this project:

- A nuclear conflict based on regional issues can escalate to a global nuclear conflict within hours or days after the first use of nuclear weapons.
- Any nuclear detonations, even in relatively unpopulated areas, are likely to result in at least thousands of deaths, with possible fallout crossing international borders, causing additional health risks and increasing political tensions even when fallout levels are low.
- Even when focused on military targets, nuclear detonations may kill many hundreds of thousands of people within days or months, as well as cause hundreds of thousands of additional cancer deaths and great economic damage.
- The impact of mass fires or firestorms that sometimes result from nuclear explosions can surpass the lethality of other direct impacts of nuclear use. Historically, military planning for nuclear use has lacked sufficient consideration of firestorm impacts.
- Many of the plausible nuclear use cases developed for this project have their genesis in misinterpretation of intentions and lack of communication between adversaries, underscoring the need for communication between nations to avert nuclear weapons use, especially during times of conflict and crisis.
- There are many plausible pathways to nuclear war that would have cataclysmic effects. Most of these pathways involve “slippery slopes” of descent into nuclear war, where an action by one party is misinterpreted by another, leading to conflict escalation that proceeds further and more rapidly than adversaries intend or foresee. As such, these potential pathways to nuclear war are often invisible to policymakers.
- It is urgent to reduce the risk of choosing or stumbling onto one of these pathways by developing and applying regional and global policy measures such as increasing transparency of nuclear stockpiles, deployments, and operational and declaratory doctrine—especially relating to integration of nuclear firestorms into nuclear targeting—such as increasing communications with nuclear hotlines.

- In addition, it is important to explore policy measures to reduce the role of nuclear weapons in security policy and to revive arms control and disarmament diplomacy. Such measures include introducing a nuclear no-first threat norm; resolving regional conflicts; and, ultimately, establishing a regional security framework including denuclearization of the Korean Peninsula and a nuclear weapon free zone in the region towards elimination of nuclear weapons altogether.

TABLE OF CONTENTS

Acknowledgments.....	ii
Executive Summary.....	iii
Project Members.....	vii
Table of Contents.....	viii
Table of Figures.....	xi
Table of Tables.....	xix
1 Summary of Results and Provisional Policy Lessons.....	1
1.1 Summary of use case evaluations.....	1
1.2 Initial policy lessons.....	6
1.3 Project next steps.....	8
1.4 Contents of subsequent sections of this Report.....	9
2 Background: Regional Setting and Project Goals.....	10
2.1 Therisks of nuclear conflict as an increasing concern for our times.....	10
2.2 Updated summary of nuclear weapons situation on the Korean Peninsula.....	11
2.3 Summary of project goals, approaches/methods, and organization.....	18
2.3.1 Approaches and methods, by project year.....	19
2.3.2 Project organization.....	20
3 Selecting Nuclear Weapons Use Cases for Analysis.....	21
3.1 Summary definitions and applications of use cases.....	21
3.1.1 What defines a use case?.....	21
3.1.2 Applications of use cases.....	22
3.1.3 Objectives in assembling and evaluating a range of use cases.....	23
3.1.4 Criteria for selecting use cases for further analysis.....	23
3.2 Use Cases Evaluated.....	24
3.3 Elaboration of use cases for quantitative evaluation.....	26
4 Evaluation of Use Cases—Impacts Considered.....	27
4.1 Introduction: Impacts of nuclear weapons use.....	27
4.2 Thermal fluence (radiative heat).....	28
4.3 Firestorms.....	30
4.4 Blast overpressure.....	34

4.5	Prompt radiation exposure	38	
4.6	Radiation exposure from fallout	39	
4.7	Delayed health effects from radiation exposure	39	
5	Methods Used to Estimate Impacts of Nuclear Detonations	40	
5.1	Introduction	40	Maps of impact contours for prompt radiation, thermal fluence, overpressure, and firestorm, Use Case 1
5.2	Evaluation of thermal fluence impacts	40	Summary of Estimated Overall Likely Deaths and Eventual Cancer Deaths in Use Case 1 from Different Impacts All Detonations:
5.3	Evaluation of firestorm impacts	42	Nuclear Fallout Simulation Results: Use Case 1
5.4	Evaluation of blast overpressure impacts	46	"US Leadership Hubris," Use Case 2:
5.5	Evaluation of prompt radiation exposure	47	Maps of impact contours for prompt radiation, thermal fluence, overpressure, and firestorm, Use Case 2
5.6	Evaluation of fallout radiation exposure	40	Summary of Estimated Overall Likely Deaths and Eventual Cancer Deaths in Use Case 2 from Different Impacts All Detonations:
5.7	Estimation of radiation-induced cancers from exposure to prompt and fallout radiation dose	52	Nuclear Fallout Simulation Results: Use Case 2: "US Leadership Hubris"
5.8	Estimation of the aggregate impact of the effects of nuclear detonation	53	"Use by Terrorist" VI, Use Case 3:
6	Estimated Fatalities Due to Nuclear Detonation Impacts	57	Maps of impact contours for prompt radiation, thermal fluence, overpressure, and firestorm, Use Case 3
6.1	Use Case 1: "We're Still Here"	57	Summary of Estimated Overall Likely Deaths and Eventual Cancer Deaths in Use Case 3 from Different Impacts
6.2	Use Case 2: "US Leadership Hubris"	61	Nuclear Fallout Simulation Results: Use Case 3: Nuclear Weapon Use by Terrorists Variant 1
6.3	Use Case 3: "Use by Terrorists" VI	67	"Conflict from Ukraine Spreads East", Use Case 4:
6.4	Use Case 4: "Conflict from Ukraine Spreads East"	71	Maps of impact contours for prompt radiation, thermal fluence, overpressure, and firestorm, Use Case 4
6.5	Use Case 5: "Not Going Well in Taiwan"	73	Summary of Estimated Overall Likely Deaths and Eventual Cancer Deaths in Use Case 4 from Different Impacts, All Detonations:
6.6	Conclusion: Overall Summary of Simulated Use Case Results and Implications	83	Nuclear Fallout Simulation Results: Use Case 4: "Conflict from Ukraine Spreads East"
Glossary		85	"Not Going Well in Taiwan", Use Case 5:
ANNEXES		86	Maps of impact contours for prompt radiation, thermal fluence, overpressure, and firestorm, Use Case 5
Annex 1: Nuclear Use Cases Developed During and Subsequent to Project Year 1 from which Evaluated Use Cases Were Selected		89	Summary of Estimated Overall Likely Deaths and Eventual Cancer Deaths in Use Case 5 from Different Impacts, All Detonations:
Suite of use cases developed during and subsequent to project Year 1, and criteria for selecting use cases for further analysis		89	Nuclear Fallout Simulation Results: Use Case 5: "Not Going Well in Taiwan"
Presentation of use cases		89	
New use cases developed after Project Year 1 incorporating lessons from Ukraine Conflict		96	
"Sending a Message, Eastern Doorstep"		96	
"Conflict from Ukraine Spreads East"		103	
Annex 2: Use Case Elaborations		106	
Annex 3: Additional Results of Use Cases Evaluation		114	
"We're Still Here" Variant 1 (Use Case 1)		114	

III. ENDNOTES

[1] There is no legal or institutional definition of Northeast or East Asia. The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) uses "East and North East Asia (ENEA) to refer to "China; Democratic People's Republic of Korea; Hong Kong, China; Japan; Macao, China; Mongolia; Republic of Korea". See UNESCAP (undated), "4 List of countries in the Asia-Pacific region and subregions", available as <https://data.unescap.org/dataviz/methodology/list-of-countries-in-the-asia-pacific-region-and-subregions.html>

An examination of the contested usage related to "Asia" and its sub-regions is found in P. Hayes and C.I. Moon, ed (2018), *The Future of East Asia*, Palgrave MacMillan, available at: <https://link.springer.com/book/10.1007/978-981-10-4977-4>

[2] Note that Individual impacts in this table may not add up to the exact total shown in column five due to rounding.

IV. NAUTILUS INVITES YOUR RESPONSE

The Nautilus Asia Peace and Security Network invites your responses to this report. Please send responses to: nautilus@nautilus.org. Responses will be considered for redistribution to the network only if they include the author's name, affiliation, and explicit consent

View this online at: <https://nautilus.org/napsnet/napsnet-special-reports/humanitarian-impact-of-nuclear-weapons-use-in-northeast-asia-implications-for-reducing-nuclear-risk/>

Nautilus Institute

608 San Miguel Ave., Berkeley, CA 94707-1535 | Phone: (510) 423-0372 | Email:

nautilus@nautilus.org